Effect of Fertilization on Microorganisms in a Long-term Field Experiment

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The long-term field experiment "Ewiger Roggenbau Halle" was established in 1878 by KÜHN /1901/.

The texture of the soil of the experimental site is Loamy Sand /lS/, the soil type is Braunschwarzerde /brown forest soil/.

The fertilizer treatments applied in the experiment are given in Table 1.

Table 1

Treatments of the long-term field experiment "Ewiger Roggenbau Halle"

Treatment	Annual fertilizer supply /kg/ha/			
	manure	N	P	K
NPK	-	40	24	75
N	-	40	-	-
PK	-	-	24	75
farmyard manure I	12 000	65	20	60
farmyard manure II /till 1952, later non-fertilized/	8 000	45	13	40
non-fertilized	-	-	-	-

The long-term field experiment can be subdivided into 3 sections: 1. Secale cereale /1878-1989/; 2. Secale cereale /1878-1960/ Solanum tuberosum/ Secale cereale /1961-1989/; 3. Secale cereale /1878-1960/ Zea mays /silage/ /1961-1989/;

Plant yields have been determined annually /GARZ, 1979; GARZ and HAGEDORN, 1989/. Physical and chemical analyses are carried out every 5 years while the biomass quality is tested at longer intervals. Investigations on soil organisms were made after 80 years /MÜLLER, 1962/, after 100 years /MÜLLER et al., 1979/ and after 109 years /HICKISCH and MACHULLA, 1989/.

Materials and methods

The soil-biological test factors were as follows: /1/ Soil bacteria; /2/ Cellulolytical bacteria; /3/ Proteolytical bacteria; /4/ Azotobacter chroococcum; /5/ Nitrosomonas sp.; /6/ Soil fungi; /7/ Collembola; /8/ Acari; /9/ CO_2 output; /10/ Stability of the soil structure; /11/ C_t content; The numbers in brackets represent the corresponding columns in Fig. 1.

The microorganisms were cultivated on special media /MÜLLER, 1965/. Collembola and Acari were isolated according to BERLESE. The soil structure was determined by means of the dipping method and the CO_2 output was measured according to MÜLLER jun. and HICKISCH /1982/.

Analyses were carried out as follows:
In 1959 from 20 March to 30 June, 30 samples per variant;
in 1978 from 1 June to 30 June, 12 samples per variant; and
in 1988 from 1 June to 30 June, 20 samples per variant. In 1959 and 1988 the presence of various species was investigated in different variants.

Results

The NPK variants revealed increased values for test factors /1-9/ after 81 and 110 years of trial /Fig. 1A and 1B/. The soil structure /10/ and C_t-content /11/ were not improved as compared with the non-fertilized plot.

On the N-treated plots increases were less frequent. Nitrosomonas /5/, fungi /6/ and CO_2-output increased. Soil structure /10/ and C_t-content equalled the data obtained from the non-fertilized plot.

In the manured variant I /annual application/ all soil-biological test factors increased. As a whole, this treatment reflected the effect of fertilization in the preceding year.

In the manured variant II /1878-1952 annual manuring, later non-fertilized/ all the soil factors tested still had noticeably higher values after 7 years without fertilizer input /1959/. After 37 years without manuring /1988/ decreased values were recorded for the first time. Soil structure /10/ and C_t-content /11/ were still improved. This variant confirms the long-lasting positive after-effect of manure application /Fig. 1/.

Table 2

Presence of soil organism species after 81 years /1959/ and 109 years /1988/ in the long-term field experiment

Identified altogether	1959 1988	Presence of species in the variants				
		manure I	manure II	NPK	N	non-fertilized
Bacteria *	24 sp.	24	23	22	23	22
	27 sp.	26	25	25	23	23
Fungi	45 sp.	43	42	41	42	44
	47 sp.	44	45	46	46	43
Collembola	16 sp.	10	12	13	12	14
	14 sp.	11	14	12	11	13

* species identified easily

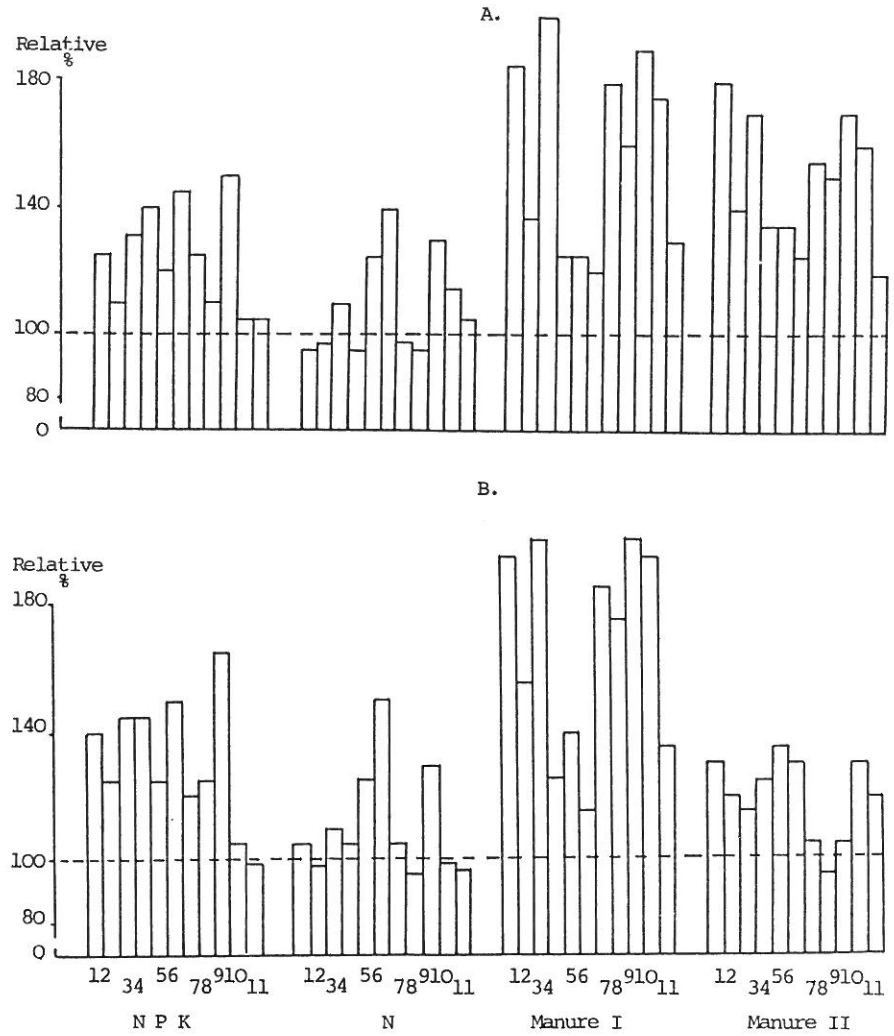

Fig. 1

Percentage of soil organisms /non-fertilized = 100%/ in the long-term field experiment after 81 years /A/ and 109 years /B/. 1. Soil bacteria; 2. Cellulolytical bacteria; 3. Proteolytical bacteria; 4. Azotobacter chroococcum; 5. Nitrosomonas sp.; 6. Soil fungi; 7. Collembola; 8. Acari; 9. CO_2 output; 10. Stability of the soil structure; 11. C_t content

All the quantitative results confirm previous knowledge in this field.

Table 2 contains data on the presence of species /not the complete spectrum/ of soil organisms which were met fairly frequently in the variants after 81 and 109 years. The table demonstrates that there has been no impoverishment of species. Mineral fertilizer application did not affect the presence of species in the soil.

The results were obtained with low fertilizer rates.

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